Public Health Apprentice Course

Food Microbiology and Chemistry

OVERVIEW

- Microbial and chemical factors in food spoilage
- Factors affecting microbial growth in foods
- Foods supporting microbial growth
- Food additives
- Prevention/control of food pathogens

Food Spoilage

- We already discussed food pathogens (the things in foods that cause people to become ill), so what causes food spoilage (bad taste/smell)?
  - Some bacteria:
    - Lactic Acid bacteria
    - *Pseudomonas* species of bacteria
    - Many others
  - Fungi

Food Spoilage (cont.)

- Microbial spoilage is not the only cause of food quality deterioration
- Chemical reactions can also reduce food quality
  - Exposure to air (oxygen causing rancidity)
  - Exposure to light (light causing rancidity)
  - Reactions caused by enzymes that are naturally present in the food leading to off-flavors

Factors Affecting Microbial Growth in Foods

There are six main factors that affect microbial growth in food:

F-

A-

T-

T-

O-

M-

F ("Food" for the microbes to eat)

Nutrients in food affect microbial growth:

- Sources of energy (e.g., sugars, proteins)
- Sources of nitrogen (e.g., proteins)
- Vitamins
- Minerals

In order for bacteria to grow, the food has to have the right nutrients for the bacteria

A (Acid--pH of the food)

- Remember the pH scale? What's the pH range of acids?
- At what pH do you think microorganisms grow best?
- Organic acids are often added to foods to lower the pH
  - Can you think of an example?
- If we lower the pH of a food, microorganisms may still grow, but they grow much slower

Acid (cont.)

- **Most pathogens do not grow at pH < 4.6**
- Some yeast and molds can grow down to pH 1.5
- So What?

Temperature and Time

What is refrigeration temperature?

In the refrigerator:

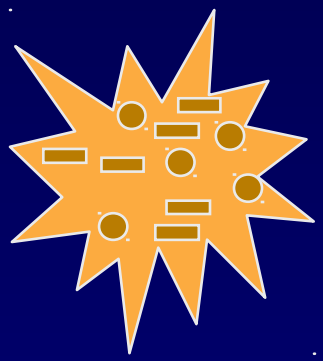
Do pathogens grow?

Do spoilage microbes grow?

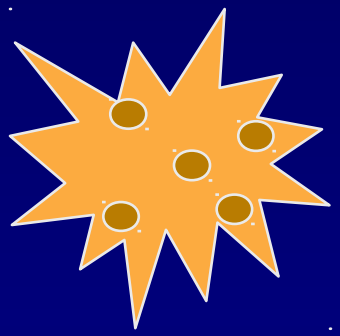
Temperature and Time (cont.)

- Heating/cooking foods (to an internal temperature of 165°F), kills most pathogens
  - What is not destroyed/killed by cooking?

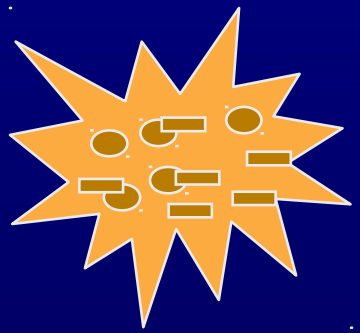
    (Remember the food pathogens lecture?)



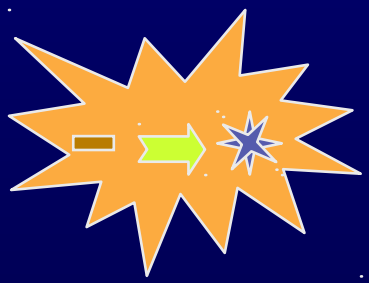
Food with vegetative cells and some spore cells



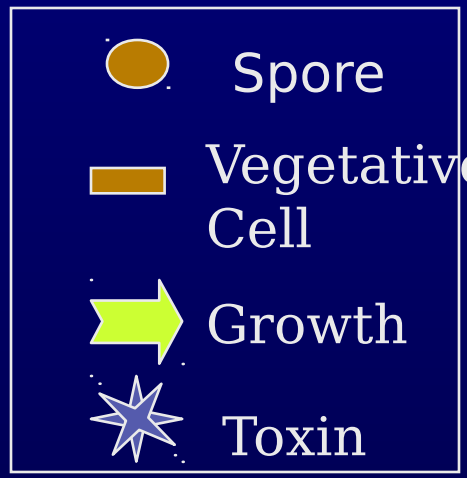
Only spores survive when food is heated (cooked) to 165 °F and then held ≥140°F



Spores can become vegetative cells again if food is not cooled properly



Vegetative cells grow to high numbers and some produce toxins



Temperature and Time (cont.)

- If food is held on a hot serving line (≥ 140°F), pathogens can NOT grow
- Most bacterial pathogens need time to grow to high enough levels or produce enough toxin to cause disease (4 hrs in the danger zone)
- One of the most common factors leading to foodborne illness is improper cooling of leftover foods!
  - Where do foods cool faster--on the counter or in the refrigerator?

“Food Safety Thermometer”

Keep hot foods hot

140°F

Danger Zone = **Temperature range of rapid pathogen growth**

41°F

Keep cold foods cold

Oxygen (Oxidation-Reduction Potential)

- Generally refers to the amount of Oxygen present
  - Most bacterial pathogens can grow with or without Oxygen
  - HOWEVER, some food pathogens can only grow when no Oxygen is present (e.g., *Clostridium botulinum*)
  - Many spoilage bacteria and molds require Oxygen to grow
- So, why do some foods get vacuum packaged (no oxygen)? Does it make the food safer?

Moisture (water)

- Why is water important to bacteria?
  - To survive?
  - To grow?
- Water in food is present in two forms:
  - BOUND
  - FREE
- Bound water is unavailable for bacteria to grow

Moisture (cont.)

Water Activity (A_w)

- A measure of the FREE WATER--water that is available for microbial growth
- A_w can range from:
  - 0.00 (no free water) to 1.00 (all free water)
- We don't measure A_w values in the Air Force, but you can look them up in food microbiology books

A_w	Foods (some examples)
0.98 to 1.00	Fresh meats, fruit, vegetables, canned fruit in light syrup, canned vegetables, beverages
0.93 to 0.98	Processed cheese, bread dough, lightly salted meats (e.g., hot dogs), canned fruit in heavy syrup
0.85 to 0.93	Ham, aged cheddar cheese, most bread, dry sausage, sweetened condensed milk
0.60 to 0.85	Flour, cereals, jams/jellies, nuts, some cheese, heavily salted foods, dried fruit
<0.60	Chocolate, honey, noodles, crackers, potato chips, dried milk, dried vegetables

Pathogens do not grow or produce toxins at $A_w < 0.85$

Adapted from APHA, Compendium of Methods for the Microbial Examination of

Common Ways to decrease A_w

How do you think the A_w of a food can be decreased?

1.

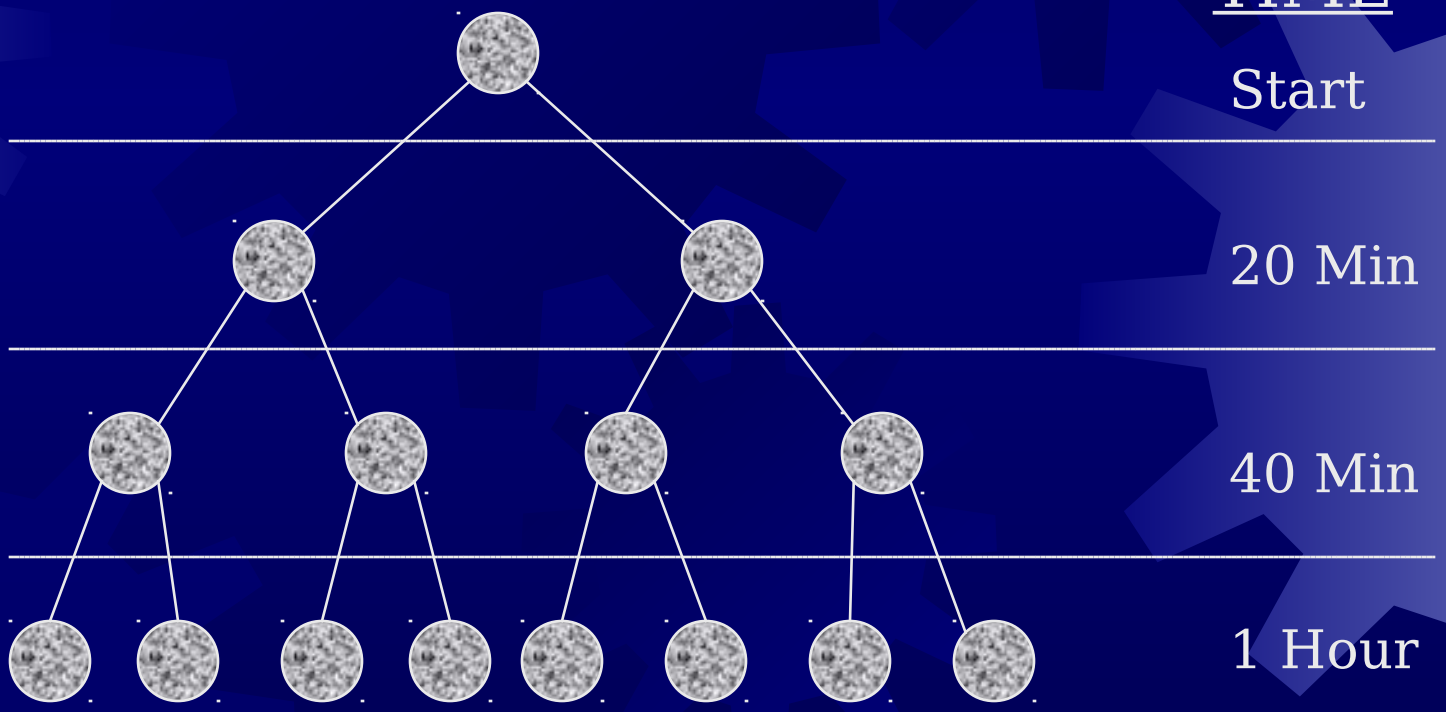
2.

3.

How do these methods work?

How Long do Bacteria Need to Grow?

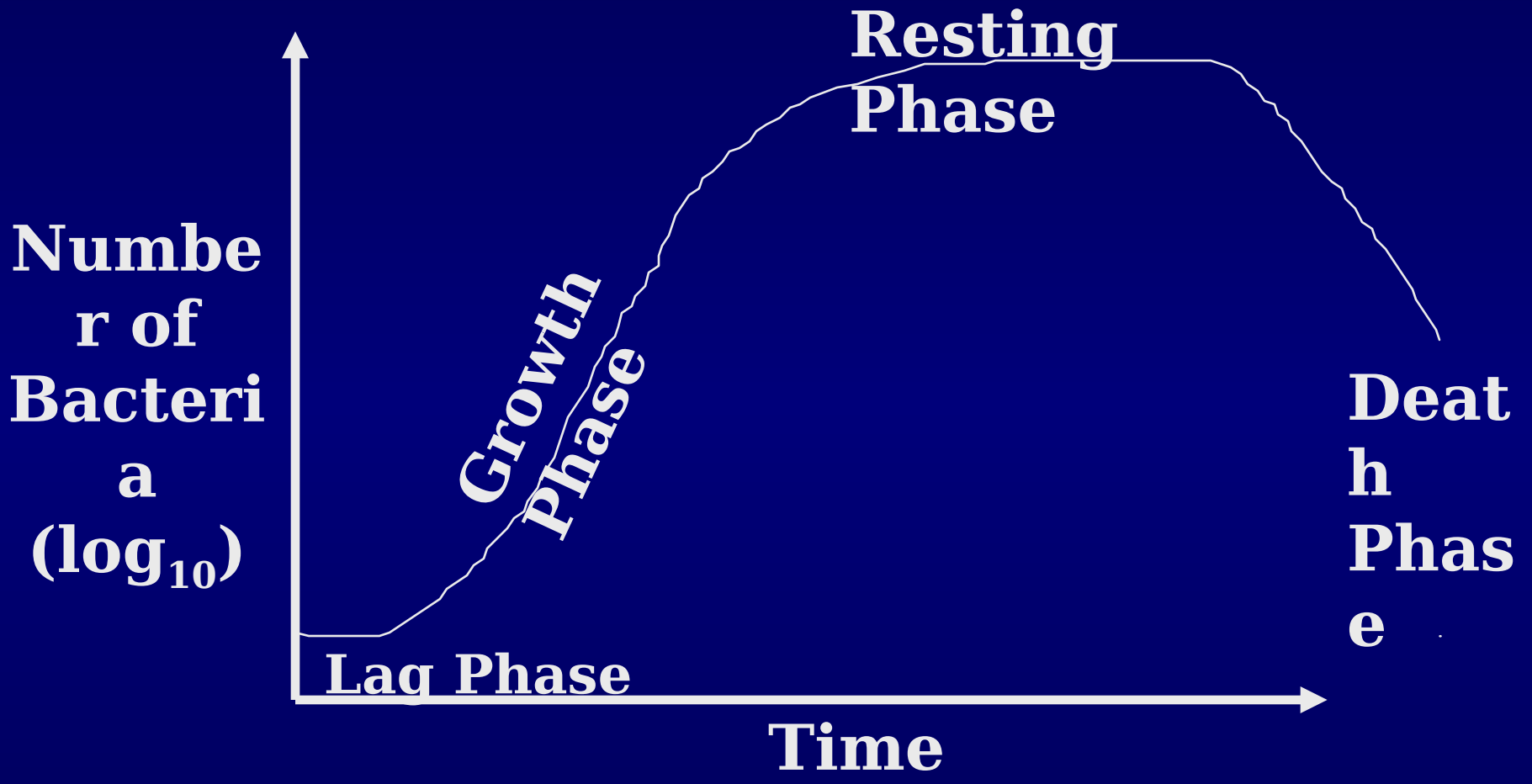
- Under ideal conditions, some bacteria can double in number every 15-30 minutes
  - Example: bacteria with a 20 min doubling time:



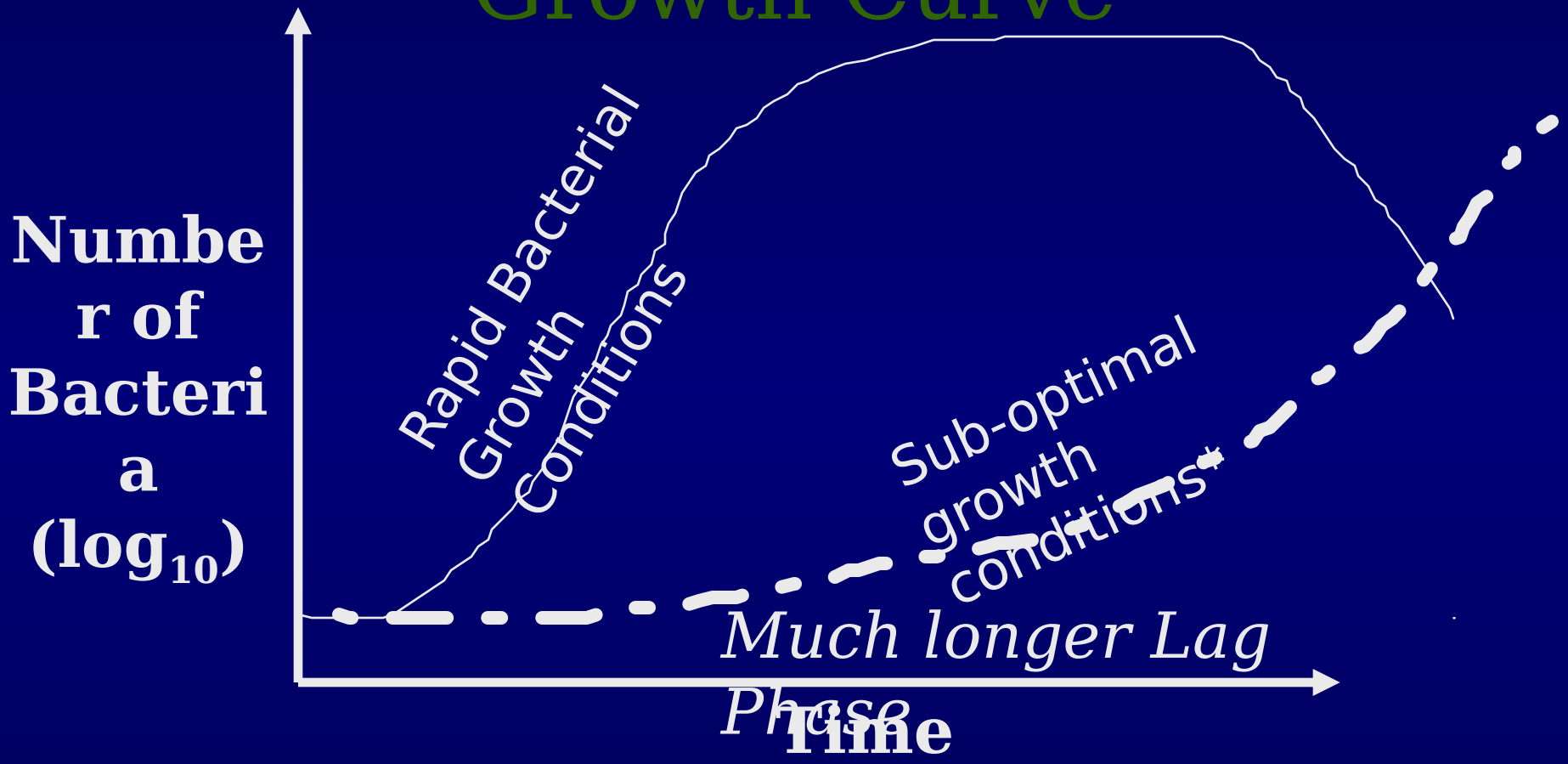
How Long do Bacteria Need to Grow?

- Exercise: 1 bacteria on a piece of potentially hazardous food sitting at 90°F, with a 20 minute doubling time:
  - How many bacteria after 1 hr? 4 hrs? 8 hrs?
  - What if there were 10,000 bacteria to start with?

Bacterial Growth Curve



Changing the Bacterial Growth Curve



*Sub-optimal means lowered: pH, A_W , Temperature, etc.

Summary of Microbial Growth

- What were the six factors?

Potentially Hazardous Foods (PHF)

- *Definition*: A food that supports growth of infectious or toxin-producing microorganisms
  - So these are the foods that have all the FAT TOM requirements for pathogen growth that we just discussed
- Examples of PHF's:
  - Raw or cooked foods of animal origin:
    - Meat, Poultry, Waterfoods, Eggs, Dairy Products
  - Some fruit and vegetables
- Could a non-PHF cause a foodborne illness?

Fruit &Vegetables (cont.)

- Which F&V are PHF's?
  - Cut melons (like cantaloupe)
    - If intact, bacteria don't grow on outer surface
    - But, when cut, bacteria are "dragged" over cut surface
    - And the pH of some melons is >4.6
  - Heated/cooked fruits and vegetables
    - Rice, beans, baked potatoes, etc. after they are cooked
  - Seed sprouts (such as alfalfa sprouts)
  - Garlic in oil mixtures

What do you think about the safety of lettuce?

Food Additives

- **Additive**
  - Government approved substances added to food during production or processing
  - Food processors add things to foods to make them taste better, look better, and have a longer shelf life (prevent microbial growth and chemical reactions)
  - Note: they can't add things to already spoiled foods that "cover up" the spoilage--it would then be an ***adulterated food***:
    - Adulterated food means one that contains poisonous ingredients, unapproved additives, or is composed of decomposed or unsanitary ingredients

Prevention/Control of Pathogens on Foods

- **What are some ways we can prevent or control pathogens on foods?**

SUMMARY

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